**3GPP SA2#159 S2-231xxxx**

**Xiamen, China, October 9 – 13, 2023** **(revision of S2-2310033)**

**Source: OPPO (Moderator of Ambient IoT)**

**Title: New SID: Study on Architecture support of Ambient power-enabled Internet of Things**

**Document for: Discussion and Approval**

**Agenda Item: 10.5**

3GPP™ Work Item Description

Information on Work Items can be found at <http://www.3gpp.org/Work-Items>   
See also the [3GPP Working Procedures](http://www.3gpp.org/specifications-groups/working-procedures), article 39 and the TSG Working Methods in [3GPP TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm)

Title: Study on Architecture support of Ambient power-enabled Internet of Things

Acronym: FS\_AmbientIoT

Unique identifier:

Potential target Release: Rel-19

# 1 Impacts

{For Normative work, identify the anticipated impacts. For a Study, identify the scope of the study}

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Affects: | UICC apps | ME | AN | CN | Others (specify) |
| Yes |  | X | X | X |  |
| No |  |  |  |  |  |
| Don't know | X |  |  |  | X |

# 2 Classification of the Work Item and linked work items

## 2.1 Primary classification

### This work item is a …

|  |  |
| --- | --- |
| X | Study |
|  | Normative – Stage 1 |
|  | Normative – Stage 2 |
|  | Normative – Stage 3 |
|  | Normative – Other\* |

## 2.2 Parent Work Item

|  |  |  |  |
| --- | --- | --- | --- |
| Parent Work / Study Items | | | |
| Acronym | Working Group | Unique ID | Title (as in 3GPP Work Plan) |
| FS\_AmbientIoT | SA1 | 950004 | Study on Ambient power-enabled Internet of Things |
| FS\_Ambient\_IoT\_RAN | RAN | 970078 | Study on Ambient IoT (Internet of Things) in RAN |

### 2.3 Other related Work Items and dependencies

|  |  |  |
| --- | --- | --- |
| Other related Work /Study Items (if any) | | |
| Unique ID | Title | Nature of relationship |
|  |  |  |

# 3 Justification

TR 22.840 is being developed by SA1 to capture use cases, traffic scenarios, device constraints of ambient power-enabled Internet of Things and identify new potential service requirements as well as new KPIs. SA1 are considering devices being either battery-less or with limited energy storage capability (i.e., using a capacitor) and the energy is provided through the harvesting of radio waves, light, motion, heat, or any other power source that could be seen suitable.

The service requirements defined in SA1 are organized into six categories in TR 22.840, and they are:

* Communications aspects of Ambient IoT devices
* Positioning/location of Ambient IoT devices
* Management of Ambient IoT devices
* Collection information and network capability exposure
* Charging
* Security and privacy

Meanwhile, RAN plenary is working on a study (TR 38.848) to check the feasibility of meeting the design targets for relevant use cases of a new 3GPP IoT technology for deployment in a 3GPP system, which relies on ultra-low complexity devices with ultra-low power consumption for very-low end IoT applications. The study is intended to provide a clear differentiation, i.e. addressing use cases and scenarios that cannot otherwise be fulfilled based on existing 3GPP IoT technology. The working assumption in this study assumes three types of devices:

* Type-A: No energy storage, no independent signal generation, i.e. backscattering transmission
* the complexity target is to be comparable to UHF RFID ISO18000-6C (EPC C1G2)
* Type-B: Has energy storage, no independent signal generation, i.e. backscattering transmission. Use of stored energy can include amplification for reflected signals
* with a complexity target such that: Device A complexity < Device B complexity < Device C complexity
* Type-C: Has energy storage, has independent signal generation, i.e. active RF component for transmission
* the complexity target is to be orders-of-magnitude lower than NB-IoT

RAN (TR 38.848) captures traffic assumption of an Ambient IoT device, which includes:

* DT: Device-terminated; and
* DO: Device-originated. While DO further includes:
* DO-A: Device-originated – autonomous; and
* DO-DTT: Device-originated – device-terminated triggered.

RAN (TR 38.848) also captures agreements on the following four connectivity topologies:

* Topology 1: BS ↔ Ambient IoT device;
* Topology 2: BS ↔ intermediate node ↔ Ambient IoT device;
* Topology 3: BS ↔ assisting node ↔ Ambient IoT device ↔ BS;
* Topology 4: UE ↔ Ambient IoT device.

Since existing technologies cannot meet all the requirements of target use cases, a new IoT technology is recommended to open new markets within 3GPP systems, whose number of connections and/or device density can be orders of magnitude higher than existing 3GPP IoT technologies. The new IoT technology shall provide complexity and power consumption orders of magnitude lower than the existing 3GPP IoT technologies (e.g. NB-IoT and eMTC), and shall address use cases and scenarios that cannot otherwise be fulfilled based on existing 3GPP IoT technologies.

From the architecture perspective, a 5G network needs to be enhanced to provide the architecture enabler to support Ambient IoT services, e.g. fulfil the requirements based on the outcome of SA1 and RAN study.

# 4 Objective

This SID studies the architecture support of ambient power-enabled IoT devices, based on the services requirements defined in 3GPP SA1.

NOTE 1: Coordination with RAN is required to determine which types of the Ambient IoT devices and which connectivity topologies as defined in TR38.848 will be in the scope of this study for all work tasks.

The objectives include:

* WT#1 Architecture to support Ambient IoT

NOTE 2: This work task will take into account the RAN study outcome and outcome of WT#3, WT#4 and WT#5.

* WT#2 Void
* WT#3 Identification, Subscription, Registration and Connection management to support Ambient IoT devices
  + WT#3.1 Study whether subscription management, registration management and/or connection management are necessary, and if so identify the necessary state machine(s), procedures and functionality considering the Ambient IoT devices capability and characteristics;
  + WT#3.2 Study whether and how reachability and paging apply to Ambient IoT device(s) considering the Ambient IoT devices capability and characteristics, and if so, what are the impacts.
  + WT#3.3 Study how to identify Ambient IoT device or group of devices and how to format the identifier.
* WT#4 Ambient IoT Services
  + WT#4.1 Study how to support information transfer for Ambient IoT services and related system functionality.

NOTE 3: E.g.whether there is a need to support E2E session considering the device types and capabilities between Ambient IoT device and the network.

* + WT#4.2 Study which Ambient IoT services enabled in WT#4.1 to be exposed to AFand how.
* WT#5 Architecture support of the following security related aspects
  + WT#5.1 Study architecture aspects to support security e.g. authentication and authorization and privacy for the Ambient IoT devices, including validation of the device’s ID
  + WT#5.2 Study how to securely disable the capability of an Ambient IoT device or a group of Ambient IoT devices to transmit RF signals.

NOTE 4: This WT requires coordination with SA3.

NOTE 5: Charging aspects for Ambient IoT will be studied by SA5

## TU estimates and dependencies

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Work Task ID** | **TU Estimate**  **(Study)** | **TU Estimate**  **(Normative)** | **RAN Dependency**  **(Yes/No/Maybe)** | **Inter Work Tasks Dependency** |
| WT#1 | 1.5 | TBD | Yes | WT#1 depends on WT#3 and WT#4 |
| WT#2 | void |  |  |  |
| WT#3 | 5 | TBD | Maybe | WT#3 depends on WT#1 and WT#5; |
| WT#3.1 | 2 |  |  |  |
| WT#3.2 | 1.5 |  |  |  |
| WT#3.3 | 1.5 |  |  |  |
| WT#4 | 4 | TBD | Maybe | WT#4 depends on WT#1 and WT#3; |
| WT#4.1 | 2 |  |  |  |
| WT#4.2 | 2 |  |  |  |
| WT#5 | 1.5 | TBD | Maybe | WT#5 depends on WT#1 and WT#3; |
| WT#5.1 | 0.75 |  |  |  |
| WT#5.2 | 0.75 |  |  |  |
| NOTE 1: This TU estimation for study phase requires further discussion;  NOTE 2: This TU estimation for normative work is assuming that TUs for normative work are equal to the TUs for the study phase (per SA2 chair’s guidance). Detailed TUs estimation also requires further discussion; Note that TU for the normative work in the table does not mean that the decision has been made to include the normative work in Rel-19. Inclusion of the normative work in Rel-19 requires further discussion. | | | | |

**Total TU estimates for the study phase:12 TUs**

**Total TU estimates for the normative phase: TBD**

**Total TU estimates: 12 + TBD**

# 5 Expected Output and Time scale

***{If this WID covers both stage 2 and stage 3, clearly indicate the different completion dates.}***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| New specifications {One line per specification. Create/delete lines as needed} | | | | | |
| Type | TS/TR number | Title | For info  at TSG# | For approval at TSG# | Rapporteur |
| Internal TR | 23.xxx | Study on Architecture support of Ambient power-enabled Internet of Things | TSG#104 (Jun. 2024) | TBD |  |

# 6 Work item Rapporteur(s)

TBD @ SA

# 7 Work item leadership

SA2

# 8 Aspects that involve other WGs

SA3 for the Security aspects,

SA5 for the Charging aspects,

RAN WGs for the RAN related issues,

# 9 Supporting Individual Members

|  |
| --- |
| Supporting IM name |
| Cybercore |
| FirstNet |
| Futurewei |
| HiSilicon |
| Huawei |
| InterDigital |
| KPN |
| Lenovo |
| NEC |
| NTT DOCOMO |
| OPPO |
| Philips |
| SHARP |
| Sony |
| vivo |
| Xiaomi |
| ZTE |